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bstract Arsad Bahri

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epada: <icmstea@unm.ac.id>

Dear Committee,

Here we attach the abstract of manuscript for publication in ICMSTEA

Regards,

Arsad Bahri
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Jurusan Biologi
Fakultas Matematika dan Ilmu Pengetahuan Alam
Universitas Negeri Makassar

Abstract Arsad Bahri.docx
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The Need of Science Learning to Empower Thinking Skills in 21st Century

Arsad Bahri[1], Asham Bin Jamaluddin[2], Andi Muharni[3], Muh. Jibran Nidhal Fikri[4], Muh. Arifuddin[1]

[1]Biology Department, Universitas Negeri Makassar, Indonesia
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Abstract. One of the characteristics of 21st century learning is the need to empower thinking skills, empowering thinking skills in learning can be done through the application of appropriate learning models. This research was a survey research that aimed to collect data about student's needs for learning models that could empower thinking skills. Respondents in this study were 47 students of the Faculty of Mathematics and Natural Sciences, State University of Makassar, Indonesia in the 2019/2020 academic year. Data about the needs of the learning model were collected through a questionnaire. The results showed that students need an innovative learning model that can activate students in the learning process, train students' creativity, facilitate students to learn collaboratively, and the students can applied their knowledge in daily life. This requires a mathematics and natural sciences learning model that is active, creative, collaborative and applicable, so as to empower thinking skills during the learning process.

Keywords: Learning model, science learning, thinking skills, active learning, collaborative learning.

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ıbstract Notification ICMSTEA 2020

:mstea@unm.ac.id <icmstea@unm.ac.id> 27 September 2020 10.0
epada: arsad.bahri@unm.ac.id

Dear Prof./Dr./Mr./Mrs. Arsad Bahri, Asham Bin Jamaluddin, Andi Muharni, Muh. Jibran Nidhal Fikri and Muh. Arifuddin

We inform you that your abstract is accepted to be presented in the 4th ICMSTEA 2020. Here I attach the Letter of Acceptance of your abstract.

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Thank you very much for joining our Conference.
See You.

Your sincerely,
Committee of ICMSTEA

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International Conference on Mathematics, Sciences, Technology Education and their Application
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
UNIVERSITAS NEGERI MAKASSAR
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Phone: +62-811-4102676 Email: icmstea@unm.ac.id
Website: http://icsmtea.conf.unm.ac.id

Makassar, September 27, 2020

Dear Prof./Dr./Mr./Mrs. **Arsad Bahri, Asham Bin Jamaluddin, Andi Muharni, Muh. Jibran Nidhal Fikri and Muh.Arifuddin**

Congratulations. On behalf of the committee, we are pleased to inform that your abstract is **ACCEPTED** to be presented at the 4th International Conference on Mathematics, Science, Technology, Education and their Application (ICMSTEA) 2020, scheduled on October 5, 2020 at virtual meeting via Zoom.

Ref. Num : **0089_ICMSTEA2020**
Title : **The Need of Science Learning to Empower Thinking Skills in 21 st Century**

Here are some important things we would like you to do in relation to the abstract's acceptance:

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3. All papers will be blind reviewed and will be published in **Journal of Physics: Conference Series (JPCS)** indexed by **Scopus**. We will inform you where your paper will be published after we have been reviewed your paper.
4. The page of papers is 8 (eight) pages. If your paper have more than **8 (eight) pages** than you must be **added fee $50** per **pages**.
5. Process reviewed will check the grammar and plagiarism. We suggest you to use Professional Translation Services **not using *Google Translate*** and using Mendeley or EndNote to manage your citation and references.
6. Full papers and the payment should be submitted no later than **September 30, 2020**.

Thank you very much for your participation and we are looking forward to seeing you via Zoom on October 5, 2020.

Your sincerely,
The chairman of ICMSTEA

Dr. Hasri, M.Si.

Note:
Click the following link to get the FullPaper Template: http://bit.ly/FullPaperTemplate-ICMSTEA

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.rsad Bahri arsad.bahri@unm.ac.id 29 September 2020 11.2
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Dear Committee,

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Regards,

Arsad Bahri
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Universitas Negeri Makassar

Fullpapaer Arsad Bahri.docx
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lotification the 4th ICMSTEA 2020

:mstea@unm.ac.id <icmstea@unm.ac.id> 4 Oktober 2020 20.4
epada: arsad.bahri@unm.ac.id

Dear Prof./Dr./Mr./Mrs. Arsad Bahri, Asham Bin Jamaluddin, Andi Muharni, Muh. Jibran Nidhal Fikri

and Muh. ArifuddinHow are you? We hope that you're doing well.
Thank you very much for joining the 4th ICMSTEA 2020.
The conference will be conducted on 5th October 2020 at 08.30 via Zoom.

In this email, we sent some files as follows:

1. Book of Abstract. You can find all of the information in this book.
https://drive.google.com/file/d/1ybi-ScYoKY-LPHVQnBnb78xN_jU-dBZz/view?usp=sharing
2. Invoice
3. Conference Rules and Zoom Meeting ID
https://drive.google.com/file/d/1uqOLp-ZUCHI95r___cJrm0mUsMCit7ik/view?usp=sharing
4. Background Zoom
https://drive.google.com/file/d/1oRvLLg1SqHTI-NPN4gacZnvl1b3keTYM/view?usp=sharing

If you have any question, don't hesitate to contact us via email.

See you on the conference.
Have a nice day.

Salam Hormat
Best Regard,

Said Fachry Assagaf
The secretary of the 4th ICMSTEA 2020
Faculty of Mathematics and Natural Sciences
Universitas Negeri Makassar.

Invoice 60 the 4th ICMSTEA 2020.pdf
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CONFERENCE RULES
The 4th ICMSTEA

Faculty of Mathematics and Natural Sciences
Universitas Negeri Makassar
Virtual Conference via Zoom, Makassar, Indonesia, 5 October 2020

Topic: 4th ICMSTEA 2020
Time: Oct 5, 2020 07.30 WIB / 08.30 WITA / 09.30 WIT

Join Zoom Meeting
https://zoom.us/j/92404057025?pwd=dmQ1QlBTejQyOGR4R2RWNUtSVllkZz09

Meeting ID: 924 0405 7025
Passcode: icmstea

1. Participants are expected to log-in to Zoom Meeting no later than 10 minutes before the conference starts
2. Presenters and participants must use the real name as registered with the following format:
   Presenter : [abstract code]_[Full name], ex: A101_Budianto Sen
   Participant: P_[Full name], ex: P_Nita Ariyani
3. During the conference, all participants are required to turn off the speaker (mute)
4. Participants are advised to use the virtual background provided by the Committee
5. During the conference, you can directly post your questions in the chat room with the following format:
   [Your Name] _ [Name of the speaker whom you want to ask] _ [Your Question]
6. All presenters and participants are required to fill in the attendance list which will be shared in the chat room.

Parallel Session Rules

1. All presenters must follow the name format as provided.
2. Each presenter will present for a maximum of 7 minutes and there will be a discussion at the end of the session.
3. All presenters need to send the presentation files before the conference starts via following link: **https://forms.gle/Jnpo4sryGdpSuuo96**
4. All participants who want to join certain parallel room need to follow the following format:

   Room A: PA_[Full name], ex: P_Nita Ariyani
   Room B: PB_[Full name], ex: P_Nita Ariyani
   Room C: PC_[Full name], ex: P_Nita Ariyani
   Room D: PD_[Full name], ex: P_Nita Ariyani
   Room E: PE_[Full name], ex: P_Nita Ariyani
5. During the parallel session, you can directly post your questions in the chat room with the following format:
   [Your Name] _ [Name of the speaker whom you want to ask] _ [Your Question]
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International Conference On Mathematics, Sciences, Technology, Education and Their Applications (ICMSTEA) 2020

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Date : 04 October 2020

Assoc. Arsad Bahri, Asham Bin Jamaluddin, Andi Muharni, Muh. Jibran Nidhal Fikri and Muh. Arifuddin

South Sulawesi 90224 Indonesia

Description	Amount
Conference Fee: 4th ICMSTEA 2020 - Paper Title : The Need of Science Learning to Empower Thinking Skills in 21 st Century - User Registration : Presenter - User Category : Authors – Local	Rp 1.500.000,-
Total	**Rp 1.500.000,-**

Thank you very much

4th ICMSTEA 2020

DIANA EKA PRATIWI
Treasurer

The Need of Science Learning to Empower Thinking Skills in 21st Century

Arsad Bahri[1], Asham Bin Jamaluddin[2], Andi Muharni[3], Muh. Jibran Nidhal Fikri[4], Muh. Arifuddin[1]

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1. INTRODUCTION

Education is currently in the knowledge age with an extraordinary increase in knowledge. In the 21st century, education is becoming increasingly important to ensure students have learning and innovation skills, skills to use technology and information media, and can work, and survive using life skills (Arifin, 2017).

Education through learning in the 21st century has a learning paradigm that emphasizes critical thinking skills, is able to connect knowledge with the real world, master information technology, communicate and collaborate (Afriyanti, 2018). One of the real forms of 21st century learning can be seen in Mipa learning, where Mipa learning emphasizes the process, students are active during learning to build their knowledge through a series of activities so that learning becomes meaningful for students (Dewi, 2016). But the fact is that in MIPA learning so far, the learning and teaching process is just memorizing facts, principles and theories (Trianto, 2014). Mipa learning is not enough with explanation and listening, but students will more easily understand the material and concepts if it is done by finding the concept itself.

This is in accordance with the opinion of Trianto (2014), that the Mipa teaching and learning process is more emphasized on the process skills approach, so that students can find facts, build their own scientific concepts, theories and attitudes which in turn can have a positive effect on the quality of educational products. But in reality students are still weak in Mathematics Learning, even though the development of Mathematics is very necessary for communication and technology development.

One of the causes of the low quality of Mathematics learning is due to the lack of active students in the learning process. The learning process is essentially a process of interaction between the teacher and students, which contains the activities of students through various interactions and learning experiences experienced by both. The learning activeness of students is one of the basic elements that are important for the success of the learning process. The learning activeness of students is considered so important in learning activities, and the active learning of these students arises because it is influenced by several factors, namely learning stimuli, attention and motivation, learned responses, strengthening, use and transfer, and the human mind has the ability to store unlimited information. the amount (Sudjana, 2010).

Another factor is caused by the teacher in applying the learning model. Some teachers have not been able to develop students' creativity in learning and are less than optimal in involving students in learning. Even students often receive negative comments in learning, so that students are passive in learning and make students feel that their inspiration is not developing and feel worthless (Delismar, 2013). Student creativity is very very important in the learning process, according to Nana (2004), because creative students have personalities such as learning to be more independent, responsible, working hard, having high motivation, being optimistic, having curiosity. who are big, confident, open, tolerant, and rich in thought. All these personalities are needed by every student in the learning process in order to develop creativity and achieve optimal learning outcomes.

The still use of conventional methods in the learning process lowers the quality of Mathematics learning. In the learning process a teacher is tasked with conveying information to students. This will not be achieved maximally if the teacher still applies conventional teaching methods or the teacher dominates the learning process compared to the role of students. The conventional approach if applied in the learning process will reduce the opportunities for students to be active, so that interaction between students is very lacking and there is no collaboration between students to work together and develop knowledge skills for the same goal, namely solving problems.

Another problem that results in the low quality of Mathematics Learning is that students do not understand the essence of the science being studied and the form of its application in everyday life, one example; When students learn the Pythagorean formula and understand the basic knowledge after that when they understand how the form of the application of this knowledge in everyday life, this should get more attention by educators to support Mathematics learning.

METHODS

This research design was a survey method to record data about the needs of mathematics learning at the Faculty of Mathematics and Natural Sciences, Makassar State University. This research was conducted in April 2020. The population were all students in the faculty of mathematics and science at Makassar State University for the 2019/2020 academic year. The sample amounted to 47 students choosen by simple random sampling that spread across 5 departments, namely the mathematics and natural sciences faculties, namely the biology department, physics department, chemistry department, mathematics department and geography department.

This research was preceded by observing. Next prepare the data collection instrument in the form of students questionnaires. Data collected through a questionnaire. The data obtained were analyzed descriptively.

RESULTS AND DISCUSSIONS

This finding presented the results of descriptive analysis about the need of science learning in the faculty of mathematics and natural sciences. The needs analysis was carried out by distributing questionnaires to students of the mathematics and natural sciences faculty, Makassar State University consisting of 47 students with major different namely; Department of Biology, Department of Chemistry, Department of Physics ,. Department of Mathematics, and Department of Geography,

The distributed questionnaire emphasizes 4 aspects of learning, namely; the active aspect (Active), the creative aspect (Creative), the collaborative aspect (Collaborative), and the applicative aspect (Applicative). In filling out the questionnaire, the following results were found;

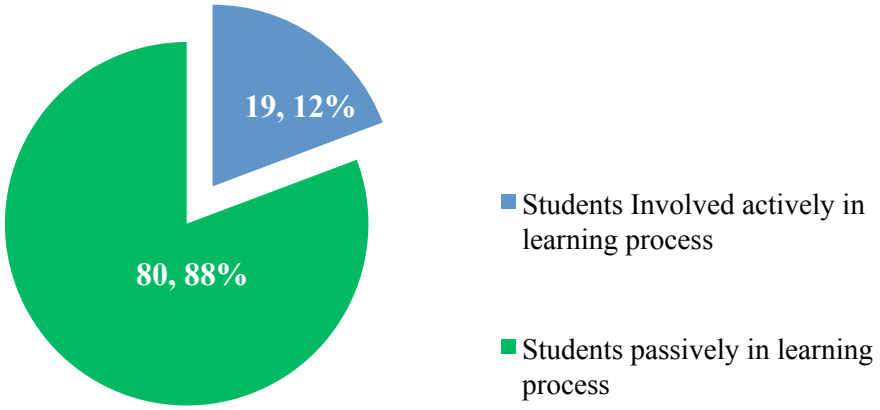

Diagram 1. Students responses related to active learning

Based on the diagram above, it can be seen that as many as 80.88% of the total respondents felt that the learning model provided so far had not stimulated student activity because the method used in the learning process according to the majority of respondents still used conventional methods such as the lecture method.

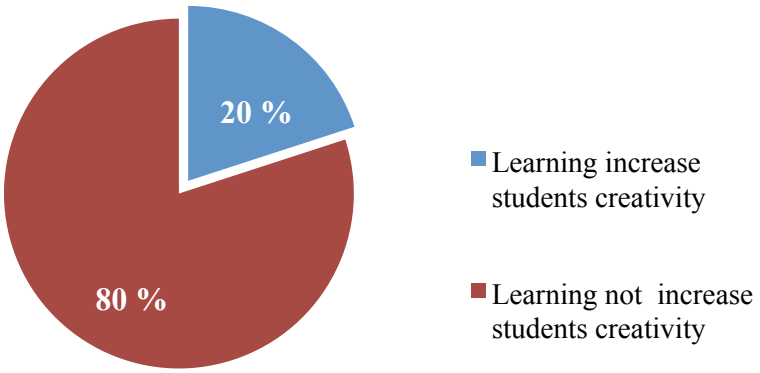

Diagram 2. Student responses related to creative learning

Based on the diagram above, it can be seen that as many as 80% of the total respondents feel that the learning model provided so far has not stimulated student creativity, this is due to the lack of strategies

used in learning and students also feel that learning is dominated by the lecture method with one-way interaction.

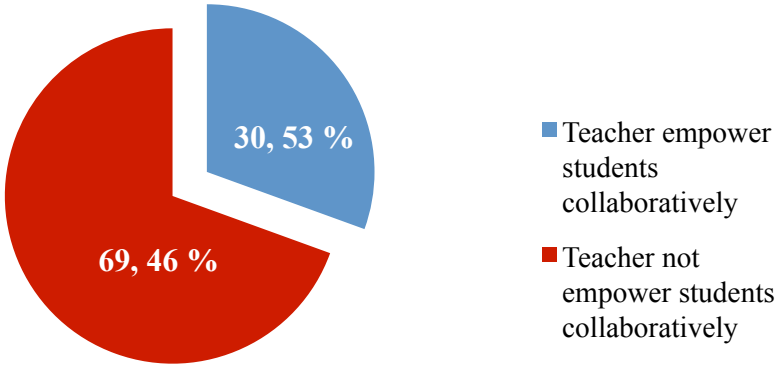

Diagram 3. Student responses related to collaborative learning

From the diagram above, it can be seen that as many as 69.46% of the total respondents feel that the learning model provided so far has not facilitated students to collaborate with other students, this is because in the learning process according to the majority of respondents there is not yet a variety of strategies used in learning that involve students interacting with one another.

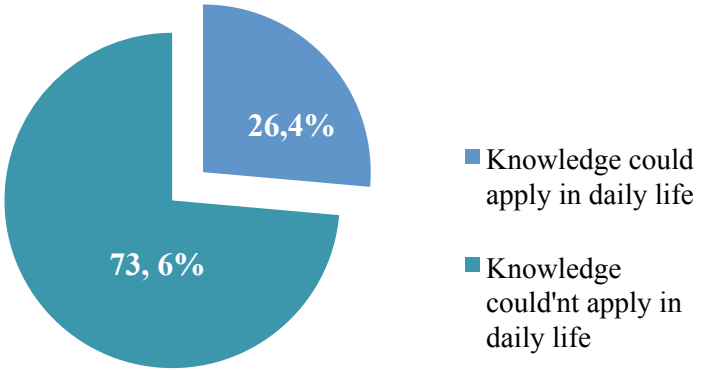

Diagram 4. Student responses related to applied learning

Based on the diagram above, it can be seen that as many as 73.6% of the total respondents feel that the learning model provided so far has not shown the direct application of knowledge in everyday life,

this is because the method used in the learning process according to the majority of respondents is only limited to practicum and does not exist. direct action to society.

The results showed that in general the lecture process that took place in the faculty of mathematics and natural sciences, Makassar State University still had not activated students, this resulted in low student involvement in the learning process. Lecturers tend to use the lecture method and end with giving assignments, lecture patterns like this have not been able to empower students 'thinking skills even though the application of innovative learning models is needed to train students' thinking skills so that students become independent learners, this is in line with the results of Bahri (2015) which shows that empowering students' thinking skills can be carried out by applying certain learning models.

Another factor, namely the lecture process that has been running so far has not stimulated student creativity, this is due to the learning model used which is not diverse and less innovative so that students tend to be passive during lectures, another factor is because students have not felt encouragement and support from the environment in the form of appreciation, support, award, praise and others. This is in accordance with what Osborn (Munandar, 2004) stated that a certain climate is needed so that a person is free to spark ideas, namely a climate where he feels safe, recognized and appreciated, with the presence of a learning climate that makes students feel encouraged and appreciated can stimulate students in improve creative thinking skills.

The results also show that the lecture process that takes place at the faculty of mathematics and natural sciences, Makassar State University still has not facilitated students to learn collaboratively, students feel that the lecture process is still thick with one-way learning nuances has not facilitated students in collaborative learning, even though learning collaboratively able to strengthen students' critical thinking in obtaining factual knowledge, this is in line with research by Gokhale (1995) which concluded that collaborative learning through discussion, clarification of ideas, and evaluation of others can strengthen critical thinking and be effective in obtaining factual knowledge. Added by Smith & MacGregor (1992), collaborative learning builds the capacity to tolerate or resolve differences and build opinions in a group.

The results showed that the results of learning obtained from the lecture process by students had not implemented it in everyday life because the learning strategies used only focused on the stages of knowing or understanding the material and not yet on the application or application stage of a concept or material. even though applied learning according to Arikunto (2017) is learning the ability to use concepts in new practices or situations.

So that in this application or application, students are required to have the ability to select or choose a certain abstraction (concepts, laws, arguments, rules, ideas, the right way to apply in new situations and apply them correctly. This is in line with Sudaryono's research (2012) concerning applicative, namely a person's ability to apply or use general ideas, methods, principles, formulas, theories and so on in new and concrete situations; includes the ability to apply a rule or method used in a concrete and new case or problem, which is expressed in the application of a formula to problems that have not been encountered or the application of a working method to new problem solving.

In other words, the ability to think applied is the ability to think where at this stage students are able to construct their knowledge, so they can link past knowledge with the knowledge they have just received.

Based on the description above, it can be seen that students need a learning model that is able to activate them in the learning process both physically and mentally besides that the learning process will be more meaningful if a learning model is applied that can train student creativity to activate all students both with high academic abilities and academic is low, the learning model is able to facilitate students to learn collaboratively so that students with different academic abilities will be able to teach each other apart from that learning will be more

meaningful if students are able to apply the knowledge obtained from college in their real life, therefore it is necessary an applicative learning model.

CONCLUSION AND SUGGESTION

Students of the faculty of mathematics and natural sciences, Makasssar State University need an active learning model that can train their creativity through active collaboration between students. Besides that, students need a learning model that is able to facilitate them to be able to apply the knowledge learned in class to their daily life so that the learning process experienced by students will be more meaningful. Through collaborative and applied active creative learning, it is hoped that students will be able to empower their thinking skills where it is needed as one of the requirements for 21st century learning.

REFERENCES

Afriyanti, Ice., Wardono., & Kartono. 2018. *Pengembangan Literasi Matematika Mengacu PISA Melalui Pembelajaran Abad Ke-21 Berbasis Teknologi*. PRISMA (1).

Arifin, Z., 2017. Mengembangkan Instrumen Pengukur Critical Thinking SkillsSiswa pada Pembelajaran Matematika Abad 21. *Jurnal THEOREMS (The Original Research of Mathematics)* 1(2), Januari 2017 hal. 92 - 100.

Arikunto, S. 2017. *Dasar-Dasar Evaluasi Pendidikan*. Jakarta: Bumi Aksara.

Bahri, A., & Aloysius, D.C. 2015. *The Contribution of learning motivation and metacognitive skill on cognitive learning outcome of students within different learning strategies. J*ournal of Baltic Science Education, 14(4),488-490

Delismar., Rayandra A., & Bambang H. 2013. *Peningkatan Kreativitas dan Keterampilan Proses Sains Siswa melalui Penerapan Model Group*. Edu-Sains Volume 1 No. 2.

Dewi, Pramita, & Sylvia., 2016. *Perspektif Guru Sebagai Implementasi Pembelajaran Inkuiri Terbuka Dan Inkuiri Terbimbing Terhadap Sikap Ilmiah Dalam Pembelajaran Sains*. Tadris: Jurnal Keguruan dan Ilmu Tarbiyah 01 (2) 179-186.

Gokhale, Anuradha A. 1995. Collaborative Learning Enhanches Critical Thinking.Journal of Technology Education. 1 (7) 1-9

Munandar. 2004. pengembangan kreativitas anak berbakat. Jakarta:PT Gramedia.

Nana, S. S. 2004. *Landasan Psikologi Proses Pendidikan*. Bandung: Remaja Rosdakarya

Smith, B. L. & MacGregor, J. T. 1992. What is collaborative learning? In Goodsell, A., Maher, M., Tinto, V., Smith, B. L. & MacGregor J. T.(Eds.), Collaborative Learning: A Sourcebook for Higher Education. Pennsylvania State University; USA, National center on postsecondary.teaching, learning, and assessment publishing.

Sudjana, N. 2014. *Penilaian Hasil Proses Belajar Mengajar*. Bandung: Rosda Karya.

Trianto. 2014. *Model Pembelajaran Terpadu*. Jakarta: Bumi Aksara.

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Result of Review

icmstea@unm.ac.id <icmstea@unm.ac.id> 2 November 2020 17.35
kepada: arsad.bahri@unm.ac.id

Dear Prof./Dr./Mr./Mrs. Arsad Bahri, Asham Bin Jamaluddin, Andi Muharni, Muh. Jibran Nidhal Fikri and Muh. Arifuddin

Here we attach the comment of reviewer on your manuscript. Please sent the revision before 8 November 2022

If you have any question, don't hesitate to contact us via email.

Have a nice day.

Salam Hormat
Best Regard,

Said Fachry Assagaf
The secretary of the 4th ICMSTEA 2020
Faculty of Mathematics and Natural Sciences
Universitas Negeri Makassar.

Reviewers Comment Arsad Bahri.docx
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Comment [1]: High Order Thinking Skills?

Comment [2]: Interview to enrich the data from questionnaire

Comment [3]: Rearrange the introduction. There were some unclear information and some statement need literature support.
Focus on High Order Thinking Skills (HOTS),
Need more literature about HOTS
How about the fact in Indonesian context

Comment [4]: ????
you mean teaching science??

One of the causes of the low quality of Mathematics learning is due to the lack of active students in the learning process. The learning process is essentially a process of interaction between the teacher and students, which contains the activities of students through various interactions and learning experiences experienced by both. The learning activeness of students is one of the basic elements that are important for the success of the learning process. The learning activeness of students is considered so important in learning activities, and the active learning of these students arises because it is influenced by several factors, namely learning stimuli, attention and motivation, learned responses, strengthening, use and transfer, and the human mind has the ability to store unlimited information. the amount (Sudjana, 2010).

Another factor is caused by the teacher in applying the learning model. Some teachers have not been able to develop students' creativity in learning and are less than optimal in involving students in learning. Even students often receive negative comments in learning, so that students are passive in learning and make students feel that their inspiration is not developing and feel worthless (Delismar, 2013). Student creativity is very very important in the learning process, according to Nana (2004), because creative students have personalities such as learning to be more independent, responsible, working hard, having high motivation, being optimistic, having curiosity. who are big, confident, open, tolerant, and rich in thought. All these personalities are needed by every student in the learning process in order to develop creativity and achieve optimal learning outcomes.

The still use of conventional methods in the learning process lowers the quality of Mathematics learning. In the learning process a teacher is tasked with conveying information to students. This will not be achieved maximally if the teacher still applies conventional teaching methods or the teacher dominates the learning process compared to the role of students. The conventional approach if applied in the learning process will reduce the opportunities for students to be active, so that interaction between students is very lacking and there is no collaboration between students to work together and develop knowledge skills for the same goal, namely solving problems.

Another problem that results in the low quality of Mathematics Learning is that students do not understand the essence of the science being studied and the form of its application in everyday life, one example; When students learn the Pythagorean formula and understand the basic knowledge after that when they understand how the form of the application of this knowledge in everyday life, this should get more attention by educators to support Mathematics learning.

METHODS

This research design was a survey method to record data about the needs of mathematics learning at the Faculty of Mathematics and Natural Sciences, Makassar State University. This research was conducted in April 2020. The population were all students in the faculty of mathematics and science at Makassar State University for the 2019/2020 academic year. The sample amounted to 47 students choosen by simple random sampling that spread across 5 departments, namely the mathematics and natural sciences faculties, namely the biology department, physics department, chemistry department, mathematics department and geography department.

This research was preceded by observing. Next prepare the data collection instrument in the form of students questionnaires. Data collected through a questionnaire. The data obtained were analyzed descriptively.

Comment [5]: Unclear infomation

RESULTS AND DISCUSSIONS

Comment [6]: Make it separately

This finding presented the results of descriptive analysis about the need of science learning in the faculty of mathematics and natural sciences. The needs analysis was carried out by distributing questionnaires to students of the mathematics and natural sciences faculty, Makassar State University consisting of 47 students with major different namely; Department of Biology, Department of Chemistry, Department of Physics ,. Department of Mathematics, and Department of Geography,

Comment [7]: Provide the data about the lecture process

The distributed questionnaire emphasizes 4 aspects of learning, namely; the active aspect (Active), the creative aspect (Creative), the collaborative aspect (Collaborative), and the applicative aspect (Applicative). In filling out the questionnaire, the following results were found;

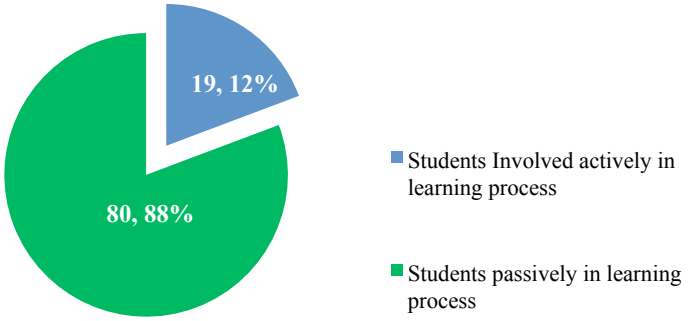

Diagram 1. Students responses related to active learning

Based on the diagram above, it can be seen that as many as 80.88% of the total respondents felt that the learning model provided so far had not stimulated student activity because the method used in the learning process according to the majority of respondents still used conventional methods such as the lecture method.

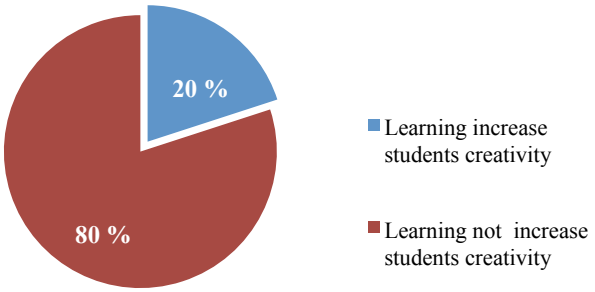

Diagram 2. Student responses related to creative learning

Based on the diagram above, it can be seen that as many as 80% of the total respondents feel that the learning model provided so far has not stimulated student creativity, this is due to the lack of strategies

used in learning and students also feel that learning is dominated by the lecture method with one-way interaction.

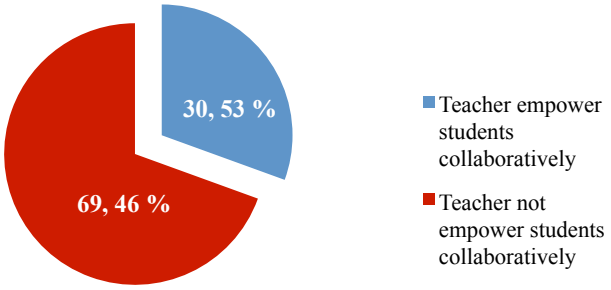

Diagram 3. Student responses related to collaborative learning

From the diagram above, it can be seen that as many as 69.46% of the total respondents feel that the learning model provided so far has not facilitated students to collaborate with other students, this is because in the learning process according to the majority of respondents there is not yet a variety of strategies used in learning that involve students interacting with one another.

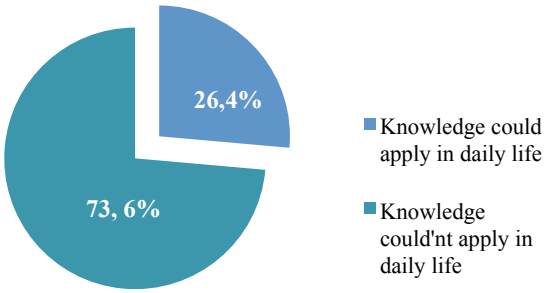

Diagram 4. Student responses related to applied learning

Comment [8]: There are too many chart but without discuss it.

Based on the diagram above, it can be seen that as many as 73.6% of the total respondents feel that the learning model provided so far has not shown the direct application of knowledge in everyday life,

this is because the method used in the learning process according to the majority of respondents is only limited to practicum and does not exist. direct action to society.

The results showed that in general the lecture process that took place in the faculty of mathematics and natural sciences, Makassar State University still had not activated students, this resulted in low student involvement in the learning process. Lecturers tend to use the lecture method and end with giving assignments, lecture patterns like this have not been able to empower students 'thinking skills even though the application of innovative learning models is needed to train students' thinking skills so that students become independent learners, this is in line with the results of Bahri (2015) which shows that empowering students' thinking skills can be carried out by applying certain learning models.

Another factor, namely the lecture process that has been running so far has not stimulated student creativity, this is due to the learning model used which is not diverse and less innovative so that students tend to be passive during lectures, another factor is because students have not felt encouragement and support from the environment in the form of appreciation, support, award, praise and others. This is in accordance with what Osborn (Munandar, 2004) stated that a certain climate is needed so that a person is free to spark ideas, namely a climate where he feels safe, recognized and appreciated, with the presence of a learning climate that makes students feel encouraged and appreciated can stimulate students in improve creative thinking skills.

The results also show that the lecture process that takes place at the faculty of mathematics and natural sciences, Makassar State University still has not facilitated students to learn collaboratively, students feel that the lecture process is still thick with one-way learning nuances has not facilitated students in collaborative learning, even though learning collaboratively able to strengthen students' critical thinking in obtaining factual knowledge, this is in line with research by Gokhale (1995) which concluded that collaborative learning through discussion, clarification of ideas, and evaluation of others can strengthen critical thinking and be effective in obtaining factual knowledge. Added by Smith & MacGregor (1992), collaborative learning builds the capacity to tolerate or resolve differences and build opinions in a group.

The results showed that the results of learning obtained from the lecture process by students had not implemented it in everyday life because the learning strategies used only focused on the stages of knowing or understanding the material and not yet on the application or application stage of a concept or material. even though applied learning according to Arikunto (2017) is learning the ability to use concepts in new practices or situations.

So that in this application or application, students are required to have the ability to select or choose a certain abstraction (concepts, laws, arguments, rules, ideas, the right way to apply in new situations and apply them correctly. This is in line with Sudaryono's research (2012) concerning applicative, namely a person's ability to apply or use general ideas, methods, principles, formulas, theories and so on in new and concrete situations; includes the ability to apply a rule or method used in a concrete and new case or problem, which is expressed in the application of a formula to problems that have not been encountered or the application of a working method to new problem solving.

In other words, the ability to think applied is the ability to think where at this stage students are able to construct their knowledge, so they can link past knowledge with the knowledge they have just received.

Based on the description above, it can be seen that students need a learning model that is able to activate them in the learning process both physically and mentally besides that the learning process will be more meaningful if a learning model is applied that can train student creativity to activate all students both with high academic abilities and academic is low, the learning model is able to facilitate students to learn collaboratively so that students with different academic abilities will be able to teach each other apart from that learning will be more

meaningful if students are able to apply the knowledge obtained from college in their real life, therefore it is necessary an applicative learning model.

Comment [9]: The discussion was too weak

CONCLUSION AND SUGGESTION

Students of the faculty of mathematics and natural sciences, Makasssar State University need an active learning model that can train their creativity through active collaboration between students. Besides that, students need a learning model that is able to facilitate them to be able to apply the knowledge learned in class to their daily life so that the learning process experienced by students will be more meaningful. Through collaborative and applied active creative learning, it is hoped that students will be able to empower their thinking skills where it is needed as one of the requirements for 21st century learning.

Comment [10]: Suggestion already include in conclusion

REFERENCES

Afriyanti, Ice., Wardono., & Kartono. 2018. *Pengembangan Literasi Matematika Mengacu PISA Melalui Pembelajaran Abad Ke-21 Berbasis Teknologi*. PRISMA (1).

Arifin, Z., 2017. Mengembangkan Instrumen Pengukur Critical Thinking SkillsSiswa pada Pembelajaran Matematika Abad 21. *Jurnal THEOREMS (The Original Research of Mathematics)* 1(2), Januari 2017 hal. 92 - 100.

Arikunto, S. 2017. *Dasar-Dasar Evaluasi Pendidikan*. Jakarta: Bumi Aksara.

Bahri, A., & Aloysius, D.C. 2015. *The Contribution of learning motivation and metacognitive skill on cognitive learning outcome of students within different learning strategies.* Journal of Baltic Science Education, 14(4),488-490

Delismar., Rayandra A., & Bambang H. 2013. *Peningkatan Kreativitas dan Keterampilan Proses Sains Siswa melalui Penerapan Model Group*. Edu-Sains Volume 1 No. 2.

Dewi, Pramita, & Sylvia., 2016. *Perspektif Guru Sebagai Implementasi Pembelajaran Inkuiri Terbuka Dan Inkuiri Terbimbing Terhadap Sikap Ilmiah Dalam Pembelajaran Sains*. Tadris: Jurnal Keguruan dan Ilmu Tarbiyah 01 (2) 179-186.

Gokhale, Anuradha A. 1995. Collaborative Learning Enhanches Critical Thinking.Journal of Technology Education. 1 (7) 1-9

Munandar. 2004. pengembangan kreativitas anak berbakat. Jakarta:PT Gramedia.

Nana, S. S. 2004. *Landasan Psikologi Proses Pendidikan*. Bandung: Remaja Rosdakarya

Smith, B. L. & MacGregor, J. T. 1992. What is collaborative learning? In Goodsell, A., Maher, M., Tinto, V., Smith, B. L. & MacGregor J. T.(Eds.), Collaborative Learning: A Sourcebook for Higher Education. Pennsylvania State University; USA, National center on postsecondary.teaching, learning, and assessment publishing.

Sudjana, N. 2014. *Penilaian Hasil Proses Belajar Mengajar*. Bandung: Rosda Karya.

Trianto. 2014. *Model Pembelajaran Terpadu*. Jakarta: Bumi Aksara.

Comment [11]: Weak reference

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Dear Committee,

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The Need of Science Learning to Empower High Order Thinking Skills in 21st Century

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Abstract. One of the characteristics of 21st century learning is the need to empower higher order thinking skills, especially in science learning. This research is a survey research that aims to determine how the learning process in the field and the desire of students to learn science in empowering higher order thinking skills. Respondents in this study were 102 students of the Faculty of Mathematics and Natural Sciences, The State University of Makassar for the academic year 2019/2020. The instrument used in the instrument sheet was a questionnaire to measure student needs and a deep interview sheet. The results showed that students considered the learning process still negative in its application process. In addition, students also need an innovative learning process that can activate students in the learning process, train critical and creative thinking skills facilitate students to always learn collaboratively, and be able to apply their knowledge in everyday life. Therefore, a solution is needed, namely the development of appropriate learning models in science learning in empowering higher order thinking skills during the learning process.

Keywords: Higher order thinking skills, science learning, learning models.

1. Introduction

21st century education is very important to consider in developing the quality of human resources (HR). In addition, education is also said to be important in ensuring that students have learning and innovation skills, skills in using technology and information media, and can work, and survive by using skills for life [1], [2]. According to Afriyanti [3], education through 21st century learning has a learning paradigm that emphasizes the ability to connect knowledge with the real world, master information technology, communicate and collaborate. In addition, learning by producing higher-order thinking outcomes is also an important goal in today's education world.

Higher order thinking skills are the ability of students to synthesize, evaluate, create and criticize and produce a product [4]. According to Tiruneh, Verburgh & Elen [5], higher-order thinking skills are a big asset in producing a problem-solving process that aims to increase one's knowledge. Students who are equipped with high-order thinking skills can become competent problem solvers, and are able to compete

in the global market, especially in getting the world of work [6]. Higher order thinking skills are very important, especially in science learning.

One of the real forms of 21st century learning in producing higher order thinking skills in the 21st century in science learning is emphasizing the learning process [7]. Students who are active during science learning can build their knowledge through a series of activities so that the learning process becomes meaningful for students [8]. According to Bustami, & Corebima [9], the process of learning science by using a process skills approach is able to make students discover facts, build their own scientific concepts, theories and attitudes which in the end can have a positive effect on the quality of educational products.

But in fact, students are still classified as weak in learning science in producing higher order thinking skills in the 21st century, even though the development of higher order thinking skills in science learning is very necessary for the development of knowledge, skills and attitudes of students [4]. According to Rosba, Zubaidah, Mahanal & Sulisetijono [10], the low level of high-order thinking skills in Indonesian students' science learning is closely related to the gap between applied science learning and the demands of 21st century learning. In addition, science learning produces higher order thinking skills. , the learning and teaching process is merely memorizing facts, principles and theories [11]. The learning process that does not have characteristics in empowering thinking skills can be said to not provide meaningful learning for students [12]. Learning is not enough just by explaining and listening, but students must be more active, easy to understand the material and concepts that exist with the activity of finding the concept itself through the learning process [13]. One of the causes of the low quality of high-order thinking skills in science learning is the learning process factor that is applied.

The learning process is a process in which there is an interaction between students and educators in building care and processes in stimulating the ecosystem by interacting with its components. The learning process is the basis for educators and students in implementing classroom learning, because there is a systematic process through the design, implementation and evaluation stages [14]. According to Arends [15], the learning process is a process or pattern that is comprehensive to help students learn certain types of knowledge, attitudes or skills. Important elements in the learning design process are students, objectives, methods and evaluation, if the four points have been planned properly; the learning process plays a very important role in producing quality output for students.

Therefore, the existing problems should be resolved from an early age by finding out what learning process is used and how the learning process is applied in the field to empower higher-order thinking skills in science learning. The existence of good thinking skills is able to overcome learning problems, especially in learning outcomes. In addition, having skills in thinking can be said to be the main key to the success of education in the 21st century today [16]. It can be concluded, that someone who has high-level thinking skills and is able to carry it out responsibly, the quality of education in Indonesia is able to achieve the goals of Indonesian education, namely "educating the nation's life" equally.

Based on the observation of the importance of high-order thinking skills in science learning in the 21st century, the problems that occur in Indonesian students, especially in higher-order thinking skills, need to be conducted a study. This study aims to determine how the application of the learning process and the desires of students in learning science in empowering higher order thinking skills in one of the tertiary institutions in South Sulawesi, The State University of Makassar.

2. Methods

The design of this study was a survey to record data on the application of the learning process that took place in the field, and the desire of students to learn science in empowering higher-order thinking skills at the Faculty of Mathematics and Natural Sciences, The State University of Makassar. This research was conducted in April 2020. The population is all students of the Faculty of Mathematics and Natural Sciences for the academic year 2019/2020. A sample of 102 students were randomly selected from five departments and two study programs (biology department, chemistry department, mathematics

department, geography department, physics department, science education study program and statistics study program) in the Faculty of Mathematics and Natural Sciences.

The data collection technique uses an instrument sheet in the form of a questionnaire in measuring student responses to the learning process carried out during the learning process in the 21st century in empowering higher order thinking skills in science learning. Questionnaire indicators consist of: 1) the use of learning models, 2), student activeness, 3) empowerment of thinking skills 4) the role of educators in learning, 5) technology in learning, and 6) follow-up activity in learning. The data obtained were analyzed descriptively. If the number of students who give positive or very positive responses is greater than or equal to 80% of the number of subjects studied, the learning process has a very good application in improving thinking skills in science learning [17]. In addition, students are also given deep interviews which consist of: 1) the learning model that is usually used, and 2) what kind of lectures the students want.

3. Results

The results of research from a needs questionnaire regarding the application of the learning process at the Faculty of Mathematics and Natural Sciences, The State University of Makassar are presented in Table 1.

Table 1 The results of the analysis of student needs for the learning process.

No	Indicators	Frequency average %			
		Highly positive	positive	negative	Highly negative
1	The use of learning models	0.00	7.25	88.63	4.12
2	Student activeness	0.00	13.53	81.96	4.51
3	Empowerment of thinking skills	0.00	2.16	91.96	5.88
4	The role of educators in learning	10.00	14.12	72.94	2.94
5	Technology in learning	12.35	20.20	64.31	3.14
6	Follow up activity in learning	10.59	22.94	62.94	3.53
	Total	5.49	13.37	77.12	4.02

Table 1 shows that the students' response to the learning process as a whole is negative with a mean value of 81.14% (mean negative and very negative). Indicators on the use of learning models, student activeness in empowering thinking skills, the role of educators in learning, technology in learning and follow-up in learning are all in the poor category because they are considered negative by students. These results indicate that the learning process in the field of science learning is very poor category.

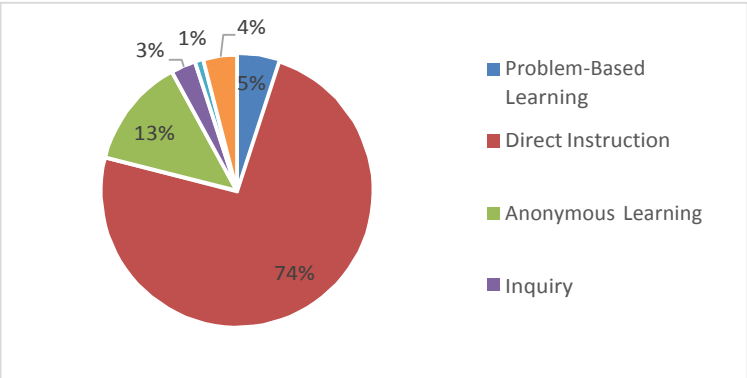

Figure 1. The learning model that is commonly used during the learning process

In the results of deep interviews, data was also obtained that during the learning process, the learning model that is always or often used is a learning model that is not able to maximize the science learning process. The learning model used during the learning process can be seen in Figure 1.

The results of deep interviews also found out what the students wanted the recovery process. The lecture process that students want is a good and effective learning process during the learning and teaching process. The coding results from deep interviews in the learning process are presented in Table 2.

Table 2. The lecture process that students want

No	Coding
1	The learning process focuses more on students
2	The use of technology during the learning process
3	There is an LKM that can always activate students in learning
4	Learning that promote critical and creative thinking processes
5	Enabling students to work collaboratively in a structured manner
6	Easy learning to do
7	Learning syntax that makes students not bored in learning
8	Educators who are able to provide good guidance during learning
9	The learning process can be applied to students

There are nine important points from the coding results in the deep interview about the lecture process that students want. The nine points are the basis for producing a learning process that is able to empower students in learning science, especially in higher-order thinking skills in the 21st century.

4. Discussions

The results showed that in general the learning process that took place at the Faculty of Mathematics and Natural Sciences, The State University of Makassar had not achieved positive results, which were classified as negative. It can be seen that the results of the analysis of student needs towards the science learning process in empowering thinking skills have not received sufficient attention. This can be seen from the student response that the use of learning models, student activeness, empowerment of thinking skills, the role of educators in learning, the presence of technology and the follow-up of the learning process have not been implemented properly. The use of learning models that are often used during the learning process also does not use learning models that can empower thinking skills. In addition, the results of the deep review also found that students' desire for a quality learning process has not been achieved, so that it has an impact on the empowerment of thinking skills, especially in higher-order thinking skills in science learning.

Higher order thinking skills are skills in more complex thinking during learning [18]. These skills can appear if the learning process provides activity to students [19]. According to Tiruneh, et al. [5], learning that activates students can provide them with a more meaningful learning experience. In addition, the role of educators in carrying out the scaffolding process for students slowly and significantly can also strengthen and empower students' thinking skills. According to Adora [20], the role of educators is absolute during the learning process in straightening and evaluating the results of student thinking. In addition, the learning process that forms critical, creative, collaborative, and unsaturated thinking processes during the learning process and applicative after learning is the learning process that students want.

The lack of critical and creative thinking processes of students during the learning process is due to the learning models used are not diverse and less innovative so that students tend to be passive during lectures. Another factor is because students have not felt encouragement and support from the environment in the form of tools, appreciation, support, giving awards, praise and factors that can give self-confidence to students [21]. This is in accordance with Duran & Dokme [22] and Listiana & Bahri [23], that it takes a certain climate and encouragement so that someone can come up with ideas. The desired climate is a climate in which students feel able to be creative, and feel encouraged and appreciated in stimulating students to empower thinking skills such as critical and creative.

The results also show that the ongoing lecture process has not been able to activate students in structured collaborative learning. Students feel that the lecture process is still thick with individualism, dominated by educators and the nuances of learning are only one way, even though collaborative learning is able to strengthen students' thinking skills in obtaining factual knowledge. This is in line with research by Gokhale [24] which states that collaborative learning through discussion, clarification of ideas, and evaluations from others can strengthen critical thinking and be effective in gaining factual knowledge. In addition, according to Al-Rahmi & Zeki [25], collaborative learning can build the capacity to tolerate or resolve differences and build opinions in a study group which has an impact on good and quality learning outcomes.

In addition, students argue that the results of the learning process cannot be implemented in everyday life because the learning strategies used only focus on the stages of knowing or understanding the material and have not reached at the application or application stage of a concept or material yet, even though applied learning uses new concepts in practice or situations can provide more meaningful learning for students. This is in line with Simonton's research [26] on applicative, namely a person's ability to apply or use general ideas, methods, principles, formulas, theories and so on in everyday life that can provide additional value to someone. In other words, the applicative ability of students can construct their knowledge, so that they can link past knowledge with the knowledge they have just received [7].

Based on the research results that have been reviewed, it appears that students need a learning process that is able to activate them in learning both physically and mentally. Learning will be more meaningful if a learning process is applied that can train thinking skills such as critical and creative thinking and can collaborate in creating a warmer social system during the learning process. In addition, the applicative abilities of students obtained from the learning process can be applied in real life, it is also important to present. Therefore, it is necessary to develop a solution, namely a learning model that can cover all the desires of students in order to produce a quality science learning process in empowering students' higher order thinking skills in the 21st century.

5. Conclusion

The learning process at the Faculty of Mathematics and Natural Sciences, The State University of Makassar is still negatively applied to students. Students need an active learning process that can practice thinking skills such as critical and creative thinking. Collaborative learning is what students want in science learning. In addition, students also need a learning process that is able to facilitate students to be able to apply the knowledge gained during the learning process into their daily life. With the solution, namely the right and quality learning model, learning will be more meaningful.

References

[1] M. Y. Abdullah, S. Hussin, and K. Ismail, “Implementation of flipped classroom model and its effectiveness on english speaking performance,” *Int. J. Emerg. Technol. Learn.*, vol. 14, no. 9, pp. 130–147, 2019.

[2] B. Santikarn and S. Wichadee, “Flipping the classroom for english language learners : A study of learning performance and perceptions,” *Int. J. Emerg. Technol. Learn.*, vol. 13, no. 9, pp. 123–135, 2018.
[3] I. Afriyanti, Wardono, and Kartono, “Pengembangan Literasi Matematika Mengacu PISA Melalui Pembelajaran Abad Ke-21 Berbasis Teknologi,” *PRISMA*, vol. 1, 2018.
[4] A. Jamaluddin, S. Zubaidah, S. Mahanal, and A. Gofur, “Character , creative thinking and learning achievement in higher education : How they are correlated,” in *The 4th International Conference on Mathematics and Science Education: AIP Conference Proceedings ICOMSE*, 2021, vol. 030030, no. March.
[5] D. T. Tiruneh, A. Verburgh, and J. Elen, “Effectiveness of critical thinking instruction in higher education: A systematic review of intervention studies.,” *High. Educ. Stud.*, vol. 4, no. 1, pp. 1–17, 2014.
[6] S. Temel, “Temel,” *South African J. Educ.*, vol. 34, no. 1, pp. 1–20, 2014.
[7] A. L. Glaze, “Teaching and Learning Science in the 21st Century: Challenging Critical Assumptions in Post-Secondary Science,” *Educ. Sci.*, vol. 8, no. 2, pp. 1–8, 2018.
[8] P. Dewi and Sylvia, “Perspektif Guru Sebagai Implementasi Pembelajaran Inkuiri Terbuka Dan Inkuiri Terbimbing Terhadap Sikap Ilmiah Dalam Pembelajaran Sains,” *Tadris J. Kegur. dan Ilmu Tarb.*, vol. 1, no. 2, pp. 179–186, 2016.
[9] Y. Bustami and A. D. Corebima, “The Effect of JiRQA Learning Strategy on Critical Thinking Skill Of Multiethnic Students in Higher Education, Indonesia,” *Int. J. Humanit. Soc. Sci. Educ.*, vol. 4, no. 3, pp. 13–22, 2017.
[10] E. Rosba, S. Zubaidah, S. Mahanal, and Sulisetijono, “College Students’ Critical Thinking Skills and Creativity,” in *The 4th International Conference on Mathematics and Science Education (ICoMSE)*, 2020.
[11] H. Suwono, H. E. Pratiwi, H. Susanto, and H. Susilo, “Enhancement of students’ biological literacy and critical thinking of biology through socio-biological case-based learning,” *J. Pendidik. IPA Indones.*, vol. 6, no. 2, 2017.
[12] S. Saragih, E. E. Napitupulu, and F. Fauzi, “Developing Learning Model Based on Local Culture and Instrument for Mathematical Higher Order Thinking Ability,” *Int. Educ. Stud.*, vol. 10, no. 6, pp. 114–122, 2017.
[13] H. Suwono and E. K. Dewi, “Problem-Based Learning Blended with Online Interaction to Improve Motivation, Scientific Communication and Higher Order Thinking Skills of High School Students,” in *International Conference for Science Educators and Teachers*, 2019.
[14] B. Joyce, M. Weil, and E. Calhoun, *Model of Teaching 6th Edition*. New Delhi: Pearson Education Inc, 2015.
[15] R. I. Arends, *Learning to Teach: ninth Edition*. New York: Mc Graw Hill Companies, 2012.
[16] I. Zain, “The Collaborative Instructional Design System (CIDS): Visualizing the 21st Century Learning,” *Univers. J. Educ. Res.*, vol. 5, no. 12, pp. 2259–2266, 2017.
[17] Hobri, *Metodologi penelitian pengembangan (Developmental Research) (Aplikasi Pada Penelitian Pendidikan Matematika)*. Jember, 2009.
[18] H. I. Arsy, A. P. B. Prasetya, and B. Subaidi, “Predict-Observe-Explain Strategy With Group Investigation Effect on Students Critical Thinking Skills and Learning Achievement,” *J. Prim. Educ.*, vol. 9, no. 1, pp. 75–83, 2020.
[19] W. K. S. Achmad, P. Bundu, Suradi, and M. Jufri, “Application of Group Investigation Learning Model in Pendidikan IPS SD Course, to Improve Student’s Critical Thinking Skills at PGSD Universitas Negeri Makasar,” *J. Res. Method Educ.*, vol. 8, no. 2, 2018.
[20] N. M. Adora, “Group Investigation in Teaching Elementary Science,” *Int. J. Humanit. Manag. Sci.*, vol. 2, no. 3, pp. 146–152, 2014.

[21] Z. C. Y. Chan, "Exploring Creativity and Critical Thinking in Traditional and Innovative Problem-based Learning Groups," *J. Clin. Nurs.*, vol. 22, pp. 2298–2307, 2013.
[22] M. Duran and I. Dokme, "The effect of the inquiry-based learning approach on student's critical thinking skills," *Eurasia J. Math. Sci. Technol. Educ.*, vol. 12, no. 12, pp. 2887–2908, 2016.
[23] L. Listiana and A. Bahri, "Empowering Student's Creative Thinking Skill in Biology Classroom: Potential of Group Investigation Combined with Think Talk Write (GITTW) Strategy," *Humanit. Soc. Sci. Rev.*, vol. 7, no. 3, pp. 477–483, 2019.
[24] A. A. Gokhale, "Collaborative Learning Enhanches Critical Thinking," *J. Technol. Educ.*, vol. 1, no. 7, pp. 1–9, 1995.
[25] W. M. Al-rahmi and A. M. Zeki, "A model of using social media for collaborative learning to enhance learners ' performance on learning," *J. King Saud Univ. - Comput. Inf. Sci.*, vol. 29, pp. 526–535, 2017.
[26] D. K. Simonton, "Creative performance, expertise acquisition, individual differences, and developmental antecedents: an integrative research agenda.," *Intelligence*, vol. 45, pp. 66–73, 2014.

CERTIFICATE

Presented to

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Rector
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Prof. Dr. H. Husain Syam, M.TP.